CHAPTER

SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1. The emulsions are the type of solution:
(a) solid in solid (b) liquid in solid (c) gas in liquid (d) none of these

2. In true solution, the particle are the type of solution:
(a) 0.1mμ (b) 10.0 mμ (c) 0.5mμ (d) 1.0 mμ

3. Which property is not for suspensions?
(a) homogeneous (b) cannot be seen by naked eye
(c) not a true solution (d) solid in liquid

4. The concentration of the solute in solution, when it is en equilibrium with solid substance, at a particular temperature is called:
(a) molarity (b) dilution
(c) colloidal solution (d) supersaturated solution

5. A solution containing relatively higher concentration of solute is called:
(a) dilute solution (b) saturated solution (c) concentrated solution (d) suspension

6. Fog is an example of solution:
(a) gas in liquid (b) liquid in gas (c) liquid in gas (d) solid in liquid

7. Emulsions are the colloidal dispersion of liquid in:
(a) solid (b) gas (c) liquid (d) water

8. The suspension particles have appearance:
(a) uniform (b) transparent (c) opaque (d) both a & b

9. Starch, glue are the examples of:
(a)colloidal solution (b) solution (c) colloids (d) crystalloids

10. Solution which can dissolve further amount of a solute at particular temperature is called:
(a) saturated solution (b) unsaturated solution
(c) colloidal solution (d) supersaturated solution

11. The solution which can easily pass through parchment membrane is considered as:
(a) colloidal solution (b) true solution (c) suspensions (d) crystalloids

12. Change of temperature can change the______ of a solute in a solvent.
(a) dilution (b) solubility (c) molarity (d) dipole moment

13. The ionic and polar compounds like NaCl and HCl are more soluble in water than non-polar covalent compounds like.
(a) CCl_4 (b) benzene (c) CS_2 (d) all of these

14. **Which one produced colloidal solution**
    (a) blood (b) cooper sulphate solution
    (c) silver nitrate solution (d) none of these

15. **Concentration is most often expressed as the ratio of the amount of ________ to the amount of solution.**
    (a) solute (b) solvent (c) brine (d) salt

16. **Number of moles of solute per dm^3 of the solution is called:**
    (a) molarity (b) molality (c) normality (d) density

17. **In sodium amalgam which two metals as present:**
    (a) Na and Mg (b) Na and Mμ (c) Na and Hg (d) Zn and Co

18. **The concentrated solution of NaCl is called:**
    (a) fluid (b) brass (c) brine (d) plasma

19. **Brass is a familiar alloy, made of:**
    (a) zinc + carbon (b) Zinc + copper (c) copper + iron (d) zinc + lead

20. **The homogeneous mixture of two or more compounds is called:**
    (a) solute (b) solvent (c) solution (d) fluid

ANSWER KEY

1	b	4	d	7	a	10	b	13	d	16	b	19	b
2	a	5	c	8	c	11	b	14	a	17	c	20	c
3	b	6	b	9	c	12	b	15	a	18	c	KIPS	

SHORT QUESTIONS

6.1 SOLUTION

Q.1 Why is a solution considered mixture?

Ans. Solution is considered as mixture because, its components are not chemically reacted, it completely shown the properties of its an compounds.

Q.2 Distinguish between the following pairs as compound or solution:

(a) water and salt solution (b) vinegar and benzene
(c) carbonated drinks and acetone

Ans.

	Compound	Solution
(a)	Water	Salt solution
(b)	Benzene	Vinegar
(c)	Acetone	Carbonated drinks

Q.3 What is the major difference between a solution and a mixture?

Ans.

Solution	Mixture
It is the homogeneous mixture of two or more substances	It is the combination of two or more things without any ratio
The quantity if solute and solvent is fixed in solution	The quantity of compounds is not fixed

Q.4 Why are the alloys considered solutions?

Ans. The solution of solids in solid is called alloy.
Example: Brass, Bronze etc.

Q.5 Dead sea is so rich with salts that it forms crystals when temperature lowers in the winter. Can you comment why is it named as "Dead Sea"?

Ans. In winter when temperature lowers the creatures or animals living in seas can not live longer because the sea is rich in salts and when winter season begin the water converts into salt crystals in which living organisms become dead or can not live any more. That is the reason these seas are known as "Dead Sea".

6.4 CONCENTRATION UNITS

Q.1 Does the percentage calculations require the chemical formula of the solute?

Ans. Yes, every percentage calculations required chemicals formula of the solute, because, molar mass is only find out by chemical formula.

Q.2 Why is the formula of solute necessary for calculation of the molarity of the solution?

Ans. As the formula of molarity shows:

$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute}} \times \frac{1000}{\text{Volume of solution in cm}^3}$$

Q.3 You are asked to prepare 15 percent (w/w) solution of common salt. How much amount of water will be required to prepare this solution?

Ans. 85 gm water will be required to prepare the 15 percent w/w solution.

Q.4 How much water should be mixed with 18 cm^3 of alcohol so as to obtain 18 % (v/v) alcohol solution?

Ans. 82 cm^3 water should be mixed with 18 cm^3 of alcohol to get 18% v/v alcohol solution.

Q.5 Calculate the concentration % (w/w) of a solution which contains 2.5 g of salt dissolved in 50 g of water.

Ans.

$$\% \text{ w/w} = \frac{\text{Mass of solute (g)}}{\text{Mass of solute + Mass of solvent}} \times 100$$

$$\% \text{ w/w} = \frac{2.5 \text{ gm}}{2.5\text{gm} + 50 \text{ gm}} \times 100$$

$$\% \text{ w/w} = \frac{25 \text{ gm}}{525\text{gm}} \times 100 = \frac{100}{21} = 4.76\ \%$$

$$\% \text{ w/w} = 4.76\ \%$$

Q.6 Which one of the following solutions is more concentrated? "one molar or three molar."

Ans. As the amount of solute is increased, its concentration or molarity also increases. So, three molar solution is more concentrated.

6.5 SOLUBILITY

Q.1 What will happen if the solute-solute forces are stronger than those of solute-solvent forces?

Ans. If solute-solute forces are stronger than those of solute-solvent forces, solute remains insoluble and solution is not formed.

Q.2 When solute-solute forces are weaker than those of solute-solvent forces? Will solution form?

Ans. Yes, the solution will from in this case. It means when solute-solute forces are weaker than those of solute-solvent forces then solution will form.

Q.3 Why is iodine soluble in CCl_4 and not in water?

Ans. Iodine soluble in CCl_4 because it is the general rule/principle of solubility that "like dissolves like", which means that polar-substances dissolve in polar-solvents while non-polar substances dissolve in non-polar solvents. Iodine and CCl_4 are both covalent in nature so iodine dissolve in CCl_4 but not in water because water is ionic in nature.

Q.4 Why test tube becomes cold when KNO_3 is dissolved in water

Ans. When KCl are added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed. Such dissolving process is called "endothermic". As shown in the equation:

$$\text{Solvent + Solute + Heat} \longrightarrow \text{Solution}$$

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Ans.

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Q.4 Why test tube becomes cold when KNO_3 is dissolved in water

Ans. When KCI are added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed. Such dissolving process is called "endothermic". As shown in the equation:

$$\text{Solvent + Solute + Heat} \longrightarrow \text{Solution}$$

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOIDS

Q.1 What is difference between colloid and suspension?

Ans.

Colloids	Suspension
The particles in colloids are large consisting of many atoms, ions or molecules. While in suspensions, the particles are of largest size. These are lager than 10-5 cm in diameter. Colloidal particles are big but they can pass through a filter paper.	In suspensions solute particles cannot pass through filter paper. Main difference between colloid and suspension is tyndall effect because colloids show this effect but suspension do not show this effect.

Q.2 Can colloids be separated by filtration, if not why?

Ans. Colloids can not be separated by filtration because the particles in colloids are big but not big enough so that they can pass through a filter paper. Hence, colloids can not be separated by filtration process.

Q.3 Why are the colloids quite stable?

Ans. A colloids appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are not true solution. Particles do not settle down for a long time, therefore, colloids are quite stable.

Q.4 Why does the colloid show tyndall effect?

Ans. The particles in colloids are smaller than suspension but larger than solution. So, they show tyndall effect in which particles of colloids scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

Q.5 What is tyndall effect and on what factors it depends?

Ans. Scattering of light in colloids is called tyndall effect. Tyndall effect is because of the particle size of colloids which is not very big nor very small particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the tyndall effect.

Q.6 Identify as colloids or suspensions from the following:

Ans. Milk, milk of magnesia, soap solution and Paint.

Suspensions	Colloids
Paints	Milk
Milk of magnesia	Soup solution

Q.7 How can you justify that milk is a colloid.

Ans. Milk is a colloid due to following reasons..

Milk particles are big but they can pass through a filter paper.

Milk particles are larger but can not seen with naked eye.

Milk particles scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

LONG QUESTIONS

Introduction

Solutions are homogeneous mixtures of two or more components. Generally, solutions are found in three physical states depending upon the physical state of the solvent, e.g. alloy is a solid solution; sea water is a liquid solution and air is a gaseous solution. There are nine types of solutions ranging from gas-gas e.g. air we breathe to solid-solid solutions e.g. dental amalgam for filling of tooth. Liquid solutions are the most common solutions because of the most common solvent water. Therefore, there is a wide variety of liquid solutions ranging from a drop of rain to oceans. Sea water is a resource of 92 naturally occurring elements.

6.1 SOLUTION

Q.No.1 Explain the solution and aqueous solution.

Definition

A solution is a homogeneous mixture of two or more substances.

Homogeneous mixture

A mixture having uniform composition is called homogeneous mixture. The boundaries of the components can't be distinguished i.e. a solution exist as one phase.

Example

- The air we breathe is a solution of several gases.
- Brass is a solid solution of Zn and Cu.
- Sugar dissolved in water.

6.1.1 Aqueous Solutions

The solution which is formed by dissolving a substance in water is called an aqueous solution.

Solvent

In aqueous solutions water is always present in greater amount and termed as solvent

Example

- Sugar in water.
- Table salt in water.
- Water is called a universal solvent because it dissolves majority of compounds present in earth's crust.

Q.No.2 How you can distinguish between solution and pure liquid?

Distinguish between solution & pure liquid:

- The simplest way to distinguish between a solution and a pure liquid is evaporation.
- The liquid which evaporates completely leaving no residue, is a pure compound
- While a liquid which leaves behind a residue on evaporation is solution.
- An alloy like brass or bronze is also a homogeneous mixture.
- Although it cannot be separated by physical means.
- It shows the properties of its components and
- It has a variable composition.

Q.No.3 How you can distinguish between solute and solvent?

6.1.2 Solute

"The component of solution which is present in smaller quantity is called solute".

Example

Salt solution is made by dissolving salt in water. So in salt solution, salt is the solute and water is solvent.

More than one solutes may be present in a solution.

In a solution if more than two substances are present, one substance acts as solvent and others behave as solutes

Example

In soft drinks, water is solvent while other substances like sugar, salts and CO_2 are solutes.

6.1.3 Solvent

The component of a solution which is present in larger quantity is called solvent.

Example

In soft drinks, water is solvent while other substances like sugar, salts and CO_2 are solutes.

Q.No.4 Define saturated and unsaturated solution. How can saturated solution be prepared?

6.2 SATURATED SOLUTION

Definition

A solution containing maximum amount of solute at a given temperature is called saturated solution".

Preparation of saturated solution

When a small amount of solute is added in a solvent, solute dissolves very easily in solvent. If the addition of solute is kept on, a stage is reached when solvent cannot dissolve more solute. At this stage, further added solute remains undissolved and it settles down at the bottom of the container.

Dynamic equilibrium in saturated solution:

On the particle level, a saturated solution is the one, in which undissolved solute is in equilibrium with dissolved solute. Solute (crystallized) Solute (dissolved)

At this stage dynamic equilibrium is established. Although dissolution and crystallization continues at a given temperature, but the net amount of dissolved solute remains constant.

6.2.1 Unsaturated Solution

A solution which contains lesser amount of solute than that which is required to saturate it at a given temperature, is called unsaturated solution".

Q.No.5 Explain supersaturated solution with a suitable example.

6.2.2 Supersaturated Solution

The solution that is more concentrated than a saturated solution is known as supersaturated solution".

Explanation

When saturated solutions are heated, they develop further capacity to dissolve more solute. Such solutions contain greater amount of solute than is required to form a saturated solution and they become more concentrated. Super- saturated solutions are not stable. Therefore, an easy way to get a supersaturated solution is to prepare a saturated solution at high temperature. It is then cooled to a temperature where excess solute crystallizes out and leaves behind a saturated solution.

Example

A saturated solution of sodium thiosulphate ($Na_2S_2O_3$) in water at 20 °C has 20.9 g of salt per 100 cm^3 of water. Less than this amount of salt per 100 cm^3 of water at 20 ^{0}C will be an unsaturated solution. A solution having more amount than 20.9 g of salt per 100 $cm^3$of water at20 ^{0}C will be a supersaturated solution.

Q.No.6 Explain the dilution of solution with a suitable example.

6.2.3 Dilution of Solution

The solutions are classified as dilute or concentrated on the basis of relative amount of solute present in them.

Dilute solutions

Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.

Concentrated solutions

Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution.

Example

Brine is a concentrated solution of common salt in water.

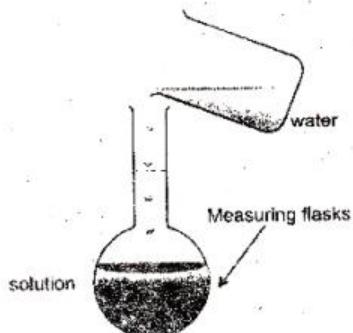



Fig. 6.1 Dilution of a solution.

Note

These terms describe the concentration of the solution. Addition of more solvent will dilute the solution and its concentration decreases.

Q.No.7 Write down the types of solution.

6.3 TYPES OF SOLUTION

Each solution consists of two components, solute and solvent. The solute as well as solvent may exist as gas, liquid or solid. So, depending upon the nature of solute and solvent different types of solutions may form

DIFFERENT TYPES OF SOLUTIONS WITH EXAMPLES

Sr. No	Solute	Solvent	Example of Solution
1	Gas	Gas	Air, mixture of H_2 and He in weather balloons, mixture of N_2 and O_2 in cylinders for respiration.
2	Gas	Liquid	Oxygen in water, carbon dioxide in water.
3	Gas	Solid	Hydrogen adsorbed on palladium.
4	Liquid	Gas	Mist, fog, liquid air pollutants.
5	Liquid	Liquid	Alcohol in water, benzene and toluene.
6	Liquid	Solid	Butter, cheese.
7	Solid	Gas	Dust particles or smoke in air.
8	Solid	Liquid	Sugar in water.
9	Solid	Solid	Metal alloys (brass, bronze), opals.

Q.No.8 Write down the types and properties of concentration units for solution.

6.4 CONCENTRATION UNITS

Properties

- Concentration is the proportion of a solute in a solution.
- It is also a ratio of amount of solute to the amount of solution or ratio of amount of solute to amount of solvent.
- Concentration does not depend upon the total volume or total amount of the solution.
- For example, a sample taken from the bulk solution will have the same concentration.

Types

There are various types of units used to express concentration of solutions

6.4.1 Percentage

Percentage unit of concentration refers to the percentage of solute present in a solution. The percentage of solute can be expressed by mass or by volume.

It can be expressed in terms of percentage composition by four different ways.

6.4.1.1 Percentage Mass/Mass (%M/M)

It is the number of grams of solute in 1 00 grams of solution.

Example

10% m/m sugar solution means that 10 g of sugar is dissolved in 90 g of water to make 100 g of solution.

Formula

$$\%m/m = \frac{\text{Mass of solute (g)}}{\text{Mass of solution (g)}} \times 100$$

6.4.1.2 Percentage - Mass/Volume (%M/V)

It is the number of grams of solute dissolved in 1 00 30 cm^3 (parts by volume) of solution.

Example

10 % m/v sugar solution contains 10 g of sugar in 100 cm^3 of solution. The exact volume of solvent is not mentioned or it is not known.

Formula

$$\%m/v = \frac{\text{Mass of solute (g)}}{\text{Volume of solution } (cm^3)} \times 100$$

6.4.1.3 Percentage - Volume/Mass (%V/M)

It is the volume in cm^3 of a solute dissolved in 100 g of the solution.

Example

For example, 10 % alcohol solution in water means 10 cm^3 of alcohol is dissolved in (unknown) volume of water so that the total weight of solution is 100 g. In such solutions the mass of solution is under consideration, total volume of the solution is not considered.

Formula

$$\%m/v = \frac{\text{Volume of solute } (cm^3)}{\text{Mass of solution (g)}} \times 100$$

6.4.1.4 Percentage – Volume/Volume (% V/V)

It is the volume in cm^3 of a solute dissolved per 100 cm^3 of the solution".

Example

30 percent alcohol solution means 30 cm^3 of alcohol dissolved in sufficient amount of water, so that the total volume of the solution becomes 100 cm^3,

Formula

$$\text{Concentration of solution}\left(v/v\right)=\frac{\text{Volume of solute}}{\text{Volume of solution}}\times 100$$

Example 6.1

If we add 5cm^3 of acetone in water to prepare 90 cm^3 of aqueous solution. Calculate the concentration (v/v) of this solution.

Solution

$$\text{Concentration of solution}\left(v/v\right)=\frac{\text{Volume of solute}}{\text{Volume of solution}}\times 100$$

$$=\frac{5}{90}\times 100=5.5$$

Thus concentration of solution is 5.5 percent by volume.

Q.No.9 **Define the molarity. How can you prepare molar solution?**

6.4.2 Molarity

It is a concentration unit defined as number of moles of solute dissolved in one dm^3 of solution. It is represented by M.

Formula:

$$\text{Molarity}=\frac{\text{Mass of solute}}{\text{Molar mass of solute}}\times\frac{1000}{\text{Volume of solution in } cm^3}$$

6.4.2.1 Preparation Of Molar Solution

One Molar solution is prepared by dissolving 1 mole (molar mass) of the solute in sufficient amount of water to make the total volume of the solution up to 1dm^3 in a measuring flask.

Example:

1M solution of NaOH is prepared by dissolving 40g of NaOH in sufficient water to make the total volume 1dm^3. As amount of solute is increased, its concentration or molarity also increases. Two M solution is more concentrated than One M solution.

6.4.2.2 Problems Involving The Molarity Of A Solution

Example 6.2

Calculate the morality of a solution which is prepared by dissolving 28.4 g of Na_2SO_4 in 400 cm^3 of solution.

Given Data:

Mass of solute = 28.4 g

Volume of solution = 400 cm^3

Molar Mass of Na_2SO_4 = 142 g/mol

Required Data:

Molarity = ?

Solution:

$$\text{No. of moles of } Na_2SO_4 = \frac{\text{Mass dissolved (g)}}{\text{Molar mass (g/mol)}}$$

$$= \frac{28.4\,g}{142\,gmol^{-1}}$$

$$\text{Conversion of volume into } dm^3 = \frac{400\,cm^3}{1000\,mol^{-1}} \times 1\,dm^3$$

$$= 0.4\,dm^3$$

$$\text{Molarity} = \frac{\text{no. of moles}}{\text{volume of solution } (dm^3)}$$

$$= \frac{0.2}{0.4}$$

Result $= \mathbf{0.5\ moldm^{-3}}$

Example 6.3

How much NaOH is required to prepare its 500 cm^3 of 0.4 M solution?

Given Data:

Volume of solution = **500 cm^3**

Molarity = **0.4 M**

Required Data:

Mass of solute = ?

Solution:

Conversion mass of solute into moles.

Molar mass of NaOH=40 g mol^{-1}

$$\text{Volume in } dm^{-3} = \frac{500\,cm^3}{1000\,cm^3} \times 1\,dm^{-3}$$

Putting the values in formula:

$$\text{Molarity} = \frac{\text{mass of solute (g)}}{\text{molar mass (g mol}^{-1}) \times \text{volume of solution } (dm^3)}$$

Mass of solute =Molarity×molar×mass×volume

=0.4×40×0.5

Result **= 4 g**

Q.No.10 How you can calculate volume for the dilution of solution?

6.4.3.1 Dilution of Solution

Dilute molar solution is prepared from a concentrated solution of known molarity.

Calculation

Suppose we are to make 100cm^3 of 0.01 M solution from given 0.1 M solution of potassium permanganate. First 0.1 M solution is prepared by dissolving 15.8 g of potassium permanganate in 1 dm^3 of solution. Then 0.01 M solution is prepared by the dilution according to following calculations:

Concentrated solution **Dilute solution**

$M_1V_1 = M_2V_2$

Given Data

$M_1 = 0.1$ M

$V_2 = 100$ cm^3

$M_2 = 0.01$ M

Required Data

$V_1 = ?$

Putting the values in above equation we get:

Concentrated solution **Dilute solution**

$V_1 \times 0.1 = 0.01 \times 100$

$V_1 = 0.01 \times 100$

Result

Concentrated solution of $KMnO_4$ has dense purple colour. We take 10 cm^3 of this solution with the help of a graduated pipette and put in a measuring flask of 100 cm^3. Add water upto the mark present at the neck of the flask. Now it is 0.01 molar solution of $KMnO_4$.

Example 6.4

10 cm^3 of 0.01 molar $KMnO_4$ solution has been diluted to 100 cm^3. Find out the molarity of this solution.

Given Data

$M_1 = 0.01$

V_1 10 cm^3

$V_2 = 100$ cm^3

Required Data

$M_2 = ?$

Solution

Using following formula, volume required can be calculated

$M_1V_1 = M_2V_2$ OR $M_2 = \frac{M_1V_1}{V_2}$

By putting these values, we get moarity:

$$M_2 = \frac{0.01 \times 10}{100}$$

Result = 0.001 M

Q. No. 1 **What is solubility? Write down the factor effecting on solubility.**

6.5 SOLUBILITY

Definition

Solubility is defined as the number of grams of the solute dissolved in 100 g of solvent to prepare a saturated solution at a particular temperature.

The concentration of a saturated solution is referred to as solubility of the solute in a given solvent.

Factor affecting the solubility

- Like dissolves like
- Solute-solvent interaction
- Temperature

Following are the factors which affect the solubility of solutes:

(i) Like dissolves like

The general principle of solubility is, like dissolves like.

- The polar substances are soluble in polar solvents.
- Ionic solids and polar covalent compounds are soluble in water

Example

- KCl.
- Na_2CO_3
- $CuSO_4$
- Sugar
- Alcohol
- Non-polar substances are not soluble in polar solvents.
- Non-polar covalent compounds are not soluble in water

Example

- Ether
- Benzene
- Petrol
- Non-polar covalent substances are soluble in non-polar solvents (mostly organic solvents).
- Grease, paints, naphthalene are soluble in ether or carbon tetrachloride etc.

(ii) Solubility and Solute-solvent interaction

The solute-solvent interaction can be explained in terms of creation of attractive forces between the particles of solute and those of solvent.

To dissolve one substance (solute) in another substance (solvent) following three events must occur:

- Solute particles must separate from each other
- Solvent particles must separate to provide space for solute particles.
- Solute and solvent particles must attract and mix up.

Explanation

- Solution formation depends upon the relative strength of attractive forces between solute-solute, solvent-solvent and solute-solvent.
- Generally solutes are solids.
- Ionic solids are arranged in such a regular pattern that the inter-ionic forces are at a maximum.
- If the new forces between solute and solvent particles overcome the solute-solute attractive forces, then solute dissolves and makes a solution.
- If forces between solute particles are strong enough than solute-solvent forces, solute remains insoluble and solution is not formed.
- The solvent molecules first pull apart the solute ions and then surround them. In this way solute dissolves and solution forms.

Example

When NaCl is added in water it dissolves readily because the attractive interaction between the ions of NaCl and polar molecules of water are strong enough to overcome the attractive forces between Na^+ and Cl^- ions in solid NaCl crystal. In this process the positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na^+ ions. These ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong that they pull these ions from their positions in the crystal and thus NaCl dissolves.

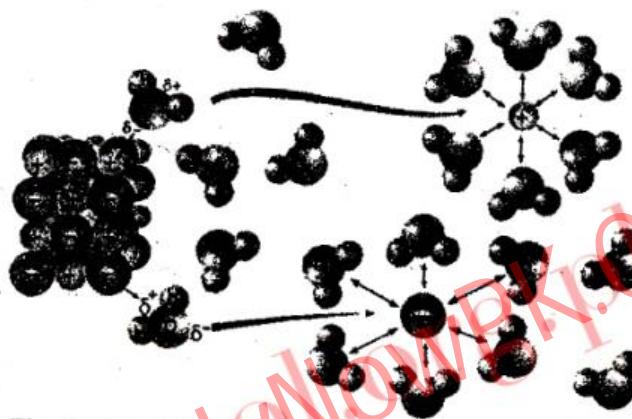
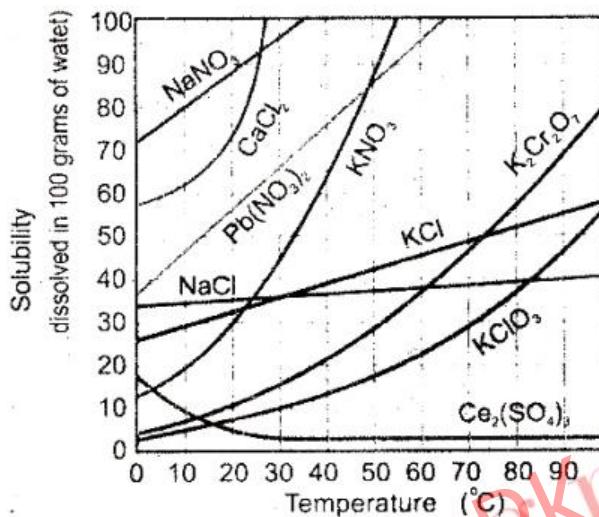



Fig. 6.2 Inter-action of solute and solvent to form solution.

Q.No.12 What is effect of temperature on solubility?

(iii) Effect of Temperature on solubility

Temperature has major effect on the solubility of most of the substances. Generally it seems that solubility increases with the increase of temperature, but it is not always true. When a solution is formed by adding a salt in solvent there are three possibilities with reference to effect of temperature on solubility.

These possibilities are discussed here.

- Heat is absorbed
- Heat is given out.

(a) Heat is absorbed

When salts like KNO_3, $NaNO_3$ and KCl are added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed. Such dissolving process is called "endothermic".

$$\text{solvent} + \text{solute} + \text{heat} \longrightarrow \longrightarrow \text{solution}$$

Solubility usually increases with the increase in temperature for such solutes. It means that heat is required to break the attractive forces between the ions of solute. This requirement is fulfilled by the surrounding molecules. As a result, their temperature falls down and test tube becomes cold.

(b) Heat is given out

When salts like Li_2SO_4 and $Ce_2(SO_4)_3$ are dissolved in water, the test tube becomes warm. i.e. heat is released during this dissolution.

solvent + solute solution + heat

In such cases, the solubility of salt decreases with the increase of temperature. In such cases attractive forces among the solute particles are weaker and solute- solvent interactions are stronger. As a result, there is release of energy.

No change in heat

In some cases during a dissolution process neither the heat is absorbed nor released. When salt like NaCl is added in water, the solution temperature remains almost the same. In such case temperature has a minimum effect on solubility .The trend of solubilities of different salts with the increase in temperature.

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOID

Q.No.13 Explain the solution, suspension and colloid.

6.6.1 True Solution

Solutions are the homogeneous mixtures of two or more than two components. Each component is mixed in such a way that their individual identity is not visible.

Example

The simplest example is that of a drop of ink mixed in water. This is an example of true solution.

Colloid

These are solutions in which the solute particles are larger than those present in the true solutions but not large enough to be seen by naked eye. The particles in such system dissolve and do not settle down for a long time.

Tyndall Effect

The particles of colloids are big enough to scatter the beam of light. It is called Tyndall effect.

Explanation

We can see the path of scattered light beam inside the colloidal solution. Tyndall effect is the main characteristic which distinguishes colloids from solutions. Hence these solutions are called false solutions or colloidal solutions.

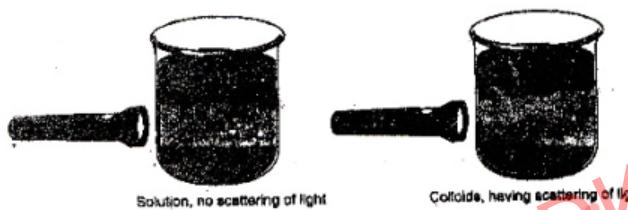



Fig. 6.4 Tyndall effect by colloids.

Examples

- Starch,
- Albumin and
- Soap solutions
- Blood
- Milk
- Ink
- Jelly
- Toothpaste

6.6.3 Suspension

Suspension is a heterogeneous mixture of undissolved particles in a given medium. Particles are being enough to be seen with naked eye.

Examples

- Chalk in water (milky suspension).
- Paints and milk of magnesia (suspension of magnesium oxide in water).

Q.No.14 **How you can compare solutions, colloidal and suspension.**

COMPARISON OF THE CHARACTERISTICS OF SOLUTION, COLLOIDAL AND SUSPENSION

Solution	Colloid	Suspension
The particles exist in their simplest form i.e. as molecules or ions. Their diameter is 10^{-8}cm.	The particles are large consisting of many atoms, ions or molecules.	The particles are of largest size. They are larger than 10^{-5}cm in diameter.
Particles dissolve uniformly throughout and form a homogeneous mixture.	A colloid appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are not true solution. Particles do not settle down for a long time, therefore, colloids are quite stable.	Particles remain undissolved and Form a heterogeneous mixture. Particles settle down after sometime
Particles are so small that they can't be seen with naked eye.	Particles are large but can't be seen with naked eye.	Particles are big enough to be seen with naked eye.
Solute particles can pass easily through a filter paper.	Although particles are big but they can pass through a filter paper.	Solute particles cannot pass through filter paper.
Particles are so small that they cannot scatter the rays of light, thus do not show tyndall effect.	Particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the tyndall effect.	Particles are so big that light is blocked and difficult to pass.

EXERCISE

MCQ'S

1. ***Mist is an example of solution:***
(a) liquid in gas (b) *gas in liquid* (c) *solid in gas* (d) *gas in solid*

2. **Which one of the following is a 'liquid in solid' solution?**
(a) sugar in water (b) butter (c) opal (d) fog

3. **Concentration is ratio of:**
(a) solvent to solute (b) solute to solution (c) solvent to solution (d) both a and b

4. **Which one of the following solutions contains more water?**
(a) 2M (b) 1M (c) 0.5 M (d) 0.25 M

5. **A 5 percent (w/w) sugar solution means that:**
(a) 5 g of sugar is dissolved in 90 g of water
(b) 5 g of sugar is dissolved in 100 g of water
(c) 5 g of sugar is dissolved in 105 g of water
(d) 5 g of sugar is dissolved in 95 g of water

6. **If the solute-solute forces are strong enough than those of solute-solvent forces. The solute:**
(a) dissolves readily (b) does not dissolve
(c) dissolves slowly (d) dissolves-and precipitates.

7. **Which one of the following will show negligible effect of temperature on its solubility?**
(a) KCl (c) $NaNO_3$ (b) KNO_3 (d) NaCl

8. **Which one of the following is heterogeneous mixture?**
(a) milk (b) ink (c) milk of magnesia (d) sugar solution

9. **Tyndall effect is shown by:**
(a) sugar solution (c) jelly (b) paints (d) chalk solution

10. **Tyndall effect is due to:**
(a) blockage of beam of light (b) non-scattering of beam of light
(c) scattering of beam of light (d) passing through beam of light

11. **If 10 cm^3 of alcohol is dissolved in 100 g of water, it is called:**
(a) % w/w (b) %w/v (c) % v/w (d) %v/v

12. **When a saturated solution is diluted it turns into:**
(a) supersaturated solution (b) saturated solution
(c) a concentrated solution (d) unsaturated solution

13. **Molarity is the number of moles of solute dissolved in:**
(a) 1kg of solution (b) 100 g of solvent
(c) 1 dm^3 of solvent (d) 1 dm^3 of solution.

ANSWR KEY

1	a	3	b	5	b	7	d	9	c	11	c	13	d
2	b	4	d	6	c	8	c	10	c	12	d	KIPS	

SHORT QUESTIONS

Q.1 Why suspensions and solutions do not show tyndall effect, while colloids do?

Ans: Suspensions and solutions do not show tyndall effect because in suspensions particles are so big that light is blocked and difficult to pass. But in solution particles are so small that they cannot scatter the rays of light, thus do not show tyndall effect. But colloids can show tyndal effect because particles scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

Q.2 What is the reason for the difference between solutions, colloids and suspensions?

Ans: Tyndall effect is the main characteristic which distinguishes colloids from solutions and suspensions because only colloids can show tyndall effect while suspensions ans solution do not show this effect.

Q.3 Why does not the suspension form a homogeneous mixture?

Ans: Suspension is a heterogeneous mixture of undissolved particles in a given medium. Particles are big enough to be seen with naked eye. These particles are so big that light is blocked and difficult to pass. That is why, solutions mixture particles should be dissolved and form a uniform mixture.

Q.4 How will you test whether given solution is a colloidal solution or not?

Ans: We will pass light in the solution, if the given solution scattered the light then it is a colloidal solution because scattering of light or tyndall effect is the main characteristic which distinguishes colloids from solution.

Q.5 Classify the following into true solution and colloidal solution Blood, starch solution, glucose solution, tooth paste, copper sulphate solution, silver nitrate solution.

Ans:

True Solutions	Colloidal Solution
Copper sulphate solution, silver nitrate solution	Blood, tooth paste, starch solution, glucose solution.

Q.6 Why we stir paints thoroughly before using?

Ans: We stir paints thoroughly before using because paint is a suspension. And suspension is a heterogeneous mix of undissolved particles in a given medium particles are big enough to be seen with naked eye particles settle down after sometime. Whenever, we use paint we stir it thoroughly because the settled down particles will suspended again in mixture and will be easy to use.

Q.7 Which of the following will scatter light and why? Sugar solution, soap solution and milk of magnesia.

Ans: Soap solution will scatter light among all because soap solution is good example of colloidal solution. colloidal solution show tyndall effect which is the main characteristic of colloidal which make them different from solutions and suspensions. So, soap is a colloidal solution.

Q.8 What do you mean, like dissolves like? Explain with examples

Ans: Like dissolves like is the general property of or general principle of solubility, which means polar solvents dissolves polar solutes while non-polar solvents dissolves non-polar solutes.

Q.9 How does nature of attractive forces of solute-solute and solvent-solvent affect the solubility?

Ans: Solution formation depends upon the relative strength of attractive forces between solute-solute, solvent and solute-solvent. Generally, solutes are solids. Ionic solids are arranged in such a regular pattern that the inter-ionic forces are the solute-solute attractive, then solute dissolves and makes a solution. if forces between solute particles are strong enough than solute-solvent forces, solute remains insoluble and solution is not formed.

Q.10 How you can explain the solute-solvent interaction to prepare a NaCI solution?

Ans: When NaCl is added in water it dissolves readily because the attractive interaction between the ions of NaCl and polar molecules of water are strong enough to overcome the attractive forces between Na^+ Cl^- ions in solid NaCl crystal. In this process, positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na+ ins. These ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong that they pull these ions from their positions in the crystal and thus NaCl dissolves.

Q.11 Justify with an example that solubility of a salt increases with the increase in temperature

Ans: Solubility of some salts which are usually ionic in nature increases with the increase in temperature for such solutes. It means that heat is required to break the attractive forces between the ions solute. This requirement falls down and test tube becomes cold.

Q.12 What do you mean by volume/volume %?

Ans: It is the volume in cm^3 of a solute dissolved in 100 g of the solution. for example: 30% of alcohol solution means 30 cm^3 of alcohol dissolved in sufficient amount of water, so that the total volume of the solution becomes 100 cm^3.

LONG QUESTIONS

(1) What is saturated solution and how it is prepared?

Ans: See the topic saturated solution.

(2) Differentiate between dilute and concentrated solutions with a common example.

Ans: See the topic dilute and concentrated solution.

(3) Explain, how dilute solutions are prepared from concentrated solutions?

Ans: See the topic preparation of dilute solution.

(4) What is molarity and give its formula to prepare molar solution?

Ans: See the topic molarity.

(5) Explain the solute-solvent interaction for the preparation of solution.

Ans: See the topic factor effecting on solubility.

(6) What is general principle of solubility?

Ans: See the topic solubility.

(7) Discuss the effect of temperature on solubility.

Ans: See the topic factor effecting on solubility.

(8) Give the five characteristics of colloid.

Ans: See the topic polarity.

(9) Give at least five characteristics of suspension

Ans: See the topic suspension.

NUMERICAL

Q.1 A solution contains 50 g of sugar dissolved in 450 g of water. What is concentration of this solution?

Given Data:

Amount of solute = 50g
Amount of solvent = 450g

Required Data

Concentration of solution = % w/w = ?

Formula

$$\%w/w = \frac{\text{mass}}{\text{solut} + \text{solvent}} \times 100$$

Solution:

$$\%\ w/w = \frac{50g}{50g + 450g} \times 100$$

$$= \frac{50g}{500g} \times 100$$

Result % w/w = 10%

Q.2 If 60 cm^3 of alcohol is dissolved in 940 cm^3 of water, what is concentration of this solution?

Given Data:

Amount of solute = v = 60 cm^3
Amount of solvent = v = 940 cm^3

Required Data

Percent v/v = % v/v = ?

Formula

$$\%v/v = \frac{\text{volume}}{\text{solut} + \text{solvent}} \times 100$$

Solution:

$$\%\ v/v = \frac{60cm^3}{60\ cm^3 + 940cm^3} \times 100$$

$$= \frac{60\ cm^3}{1000cm^3} \times 100$$

Result % v/v = 6%

Q.3 How much salt will be required to prepare following solutions (atomic mass: K=39; Na=23; S=32; 0=16 and H=I)

(a) 250 cm^3 of KOH solution of 0.5 M
(b) 600 cm^3 of $NaNO_3$ solution of 0.25 M
(c) 800 cm^3 of Na_2SO_4 solution of 1.0 M

(a)

Given Data:

Molarity = M = 0.5 M
Volume of solution = 250 cm^3

Required Data

Amount of KOH = m = ?

Formula

$$\text{Amount of solute} = \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$$

Solution:

Molecular mass $= 39 + 16 + 1 = 56g$

$$\text{Amount of solute} = \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$$

$$\text{Amount of KOH} = \frac{0.5 \times 56 \times 250}{1000}$$

$= 7.0g$

Result **$= 7g$**

(b)

Given Data:

Molarity $= M = 0.25M$
Volume of solution $= V = 600\ cm^3$
Molecular mass of $NaNO_3$ $= 23 + 14 + 48$
$= 85g$

Required Data

Amount of $NaNO_3$ $= m = ?$

Formula

$$\text{Amount of solute} = \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$$

Solution

$$\text{Amount of } NaNO_3 = \frac{0.25 \times 85g \times 600\ cm^3}{1000\ cm^3}$$

$$\frac{0.25 \times 85 \times 6}{10} g$$

$$= \frac{0.25 \times 510}{10} g$$

Result **$= 12.75g$**

(c)

Given Data:

Molarity $= M = 0.1\ M$
Volume of solution $= V = 800\ cm^3$
Molecular mass of Na_2SO_4 $= 23 \times 2 + 32 + 16 \times 4$
$= 46 + 32 + 64$
$= 142g$

Required Data

Amount of Na_2SO_4 $= m = ?$

Formula

$$\text{Amount of solute} = \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$$

Solution

Amount of Na_2SO_4 $= \frac{0.1 \times 142g \times 800\ cm^3}{1000\ cm^3}$

$= \frac{0.1 \times 142 \times 8}{10} g$

Result $= \mathbf{11.32g}$

Q.4 When we dissolve 20 g of NaCl in 400 cm³ of solution, what will be its molarity?

Given Data:

Amount of NaCl $= m = 20g$

Formula mass of NaCl $= 23 + 35.5 = 58.5g$

Volume of Solution $= v = 400\ cm^3$

Required Data

Molarity $= ?$

Formula

Molarity (m) $= \frac{\text{Amount of solute}}{\text{Formula mass}} \times \frac{\text{volume of solute}\ (cm^3)}{1000\ cm^3}$

Solution:

$= \frac{20g}{58.5g} \times \frac{400\ cm^3}{1000\ cm^3}$

$= \frac{80}{585}$

Result M $= \mathbf{0.136M}$

Q.5 We desire to prepare 100 cm³ 0.4 M solution of Mg Cl₂, how much Mg Cl₂ is needed?

Given Data:

Molarity (M) $= 0.4\ M$

Volume of Solution $= 100cm^3$

Mass of $MgCl_2$ $= 24 + 71 = 95g$

Required Data

Amount of $MgCl_2$ $= m = ?$

Formula

Amount of solute $= \frac{\text{Molarity} \times \text{Formula mass} \times \text{volume}\ (cm^3)}{1000\ cm^3}$

Solution:

$= \frac{0.4\ M \times 95\ g \times 100\ cm^3}{1000\ cm^3}$

$= \frac{38.08}{10}$

Result $= \mathbf{3.8\ g}$

12 M H_2SO_4 solution is available in the laboratory. We need only $500 cm^3$ of 0.1 M solution, how it will be prepared?

Given Data:

Molarity of concentrated solution $= M_1 = 12\ M$

Molarity of dilute solution $= M_2 = 0.1\ M$

Volume of dilute solution $= V_2 = 500 cm^3$

Required Data

Volume of concentrated solution $= V_1 = ?$

Formula

$$M_1 V_1 = M_2 V_2$$

Solution:

$$V_1 = \frac{M_2 V_2}{M_1}$$

$$V_1 = \frac{0.1M \times 500\ cm^3}{12M}$$

$$V_1 = \frac{1}{10 \times 12} \times 500\ cm^3$$

$$V_1 = \frac{500}{120}\ cm^3$$

Result $4.16\ cm^3$

CHAPTER

SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1. **The emulsions are the type of solution:**
   (a) solid in solid (b) liquid in solid (c) gas in liquid (d) none of these
2. **In true solution, the particle are the type of solution:**
   (a) 0.1mμ (b) 10.0 mμ (c) 0.5mμ (d) 1.0 mμ
3. **Which property is not for suspensions?**
   (a) homogeneous (b) cannot be seen by naked eye
   (c) not a true solution (d) solid in liquid
4. **The concentration of the solute in solution, when it is en equilibrium with solid substance, at a particular temperature is called:**
   (a) molarity (b) dilution
   (c) colloidal solution (d) supersaturated solution
5. **A solution containing relatively higher concentration of solute is called:**
   (a) dilute solution (b) saturated solution (c) concentrated solution (d) suspension
6. **Fog is an example of solution:**
   (a) gas in liquid (b) liquid in gas (c) liquid in gas (d) solid in liquid
7. **Emulsions are the colloidal dispersion of liquid in:**
   (a) solid (b) gas (c) liquid (d) water
8. **The suspension particles have appearance:**
   (a) uniform (b) transparent (c) opaque (d) both a & b
9. **Starch, glue are the examples of:**
   (a)colloidal solution (b) solution (c) colloids (d) crystalloids
10. **Solution which can dissolve further amount of a solute at particular temperature is called:**
    (a) saturated solution (b) unsaturated solution
    (c) colloidal solution (d) supersaturated solution
11. **The solution which can easily pass through parchment membrane is considered as:**
    (a) colloidal solution (b) true solution (c) suspensions (d) crystalloids
12. **Change of temperature can change the______ of a solute in a solvent.**
    (a) dilution (b) solubility (c) molarity (d) dipole moment
13. **The ionic and polar compounds like NaCl and HCl are more soluble in water than non-polar covalent compounds like.**
    (a) CCl_4 (b) benzene (c) CS_2 (d) all of these

14. **Which one produced colloidal solution**

(a) blood (b) cooper sulphate solution
(c) silver nitrate solution (d) none of these

15. **Concentration is most often expressed as the ratio of the amount of _________ to the amount of solution.**

(a) solute (b) solvent (c) brine (d) salt

16. **Number of moles of solute per dm^3 of the solution is called:**

(a) molarity (b) molality (c) normality (d) density

17. **In sodium amalgam which two metals as present:**

(a) Na and Mg (b) Na and Mμ (c) Na and Hg (d) Zn and Co

18. **The concentrated solution of NaCl is called:**

(a) fluid (b) brass (c) brine (d) plasma

19. **Brass is a familiar alloy, made of:**

(a) zinc + carbon (b) Zinc + copper (c) copper + iron (d) zinc + lead

20. **The homogeneous mixture of two or more compounds is called:**

(a) solute (b) solvent (c) solution (d) fluid

ANSWER KEY

1	b	4	d	7	a	10	b	13	d	16	b	19	b
2	a	5	c	8	c	11	b	14	a	17	c	20	c
3	b	6	b	9	c	12	b	15	a	18	c	KIPS	

SHORT QUESTIONS

6.1 SOLUTION

Q.1 Why is a solution considered mixture?

Ans. Solution is considered as mixture because, its components are not chemically reacted, it completely shown the properties of its an compounds.

Q.2 Distinguish between the following pairs as compound or solution:

(a) water and salt solution (b) vinegar and benzene

(c) carbonated drinks and acetone

Ans.

	Compound	Solution
(a)	Water	Salt solution
(b)	Benzene	Vinegar
(c)	Acctone	Carbonated drinks

Q.3 What is the major difference between a solution and a mixture?

Ans.

Solution	Mixture
It is the homogeneous mixture of two or more substances	It is the combination of two or more things without any ratio
The quantity if solute and solvent is fixed in solution	The quantity of compounds is not fixed

Q.4 Why are the alloys considered solutions?

Ans. The solution of solids in solid is called alloy.

Example: Brass, Bronze etc.

Q.5 Dead sea is so rich with salts that it forms crystals when temperature lowers in the winter. Can you comment why is it named as "Dead Sea"?

Ans. In winter when temperature lowers the creatures or animals living in seas can not live longer because the sea is rich in salts and when winter season begin the water converts into salt crystals in which living organisms become dead or can not live any more. That is the reason these seas are known as "Dead Sea".

6.4 CONCENTRATION UNITS

Q.1 Does the percentage calculations require the chemical formula of the solute?

Ans. Yes, every percentage calculations required chemicals formula of the solute, because, molar mass is only find out by chemical formula.

Q.2 Why is the formula of solute necessary for calculation of the molarity of the solution?

Ans. As the formula of molarity shows:

$$\text{Molarity} = \frac{\text{Mass of solute}}{\text{Molar mass of solute}} \times \frac{1000}{\text{Volume of solution in cm}^3}$$

Q.3 You are asked to prepare 15 percent (w/w) solution of common salt. How much amount of water will be required to prepare this solution?

Ans. 85 gm water will be required to prepare the 15 percent w/w solution.

Q.4 How much water should be mixed with 18 cm^3 of alcohol so as to obtain 18 % (v/v) alcohol solution?

Ans. 82 cm^3 water should be mixed with 18 cm^3 of alcohol to get 18% v/v alcohol solution.

Q.5 Calculate the concentration % (w/w) of a solution which contains 2.5 g of salt dissolved in 50 g of water.

Ans.

$$\% \text{ w/w} = \frac{\text{Mass of solute (g)}}{\text{Mass of solute + Mass of solvent}} \times 100$$

$$\% \text{ w/w} = \frac{2.5 \text{ gm}}{2.5\text{gm} + 50 \text{ gm}} \times 100$$

$$\% \text{ w/w} = \frac{25 \text{ gm}}{525\text{gm}} \times 100 = \frac{100}{21} = 4.76 \%$$

$$\% \text{ w/w} = 4.76 \%$$

Q.6 Which one of the following solutions is more concentrated? "one molar or three molar."

Ans. As the amount of solute is increased, its concentration or molarity also increases. So, three molar solution is more concentrated.

6.5 SOLUBILITY

Q.1 What will happen if the solute-solute forces are stronger than those of solute-solvent forces?

Ans. If solute-solute forces are stronger than those of solute-solvent forces, solute remains insoluble and solution is not formed.

Q.2 When solute-solute forces are weaker than those of solute-solvent forces? Will solution form?

Ans. Yes, the solution will from in this case. It means when solute-solute forces are weaker than those of solute-solvent forces then solution will form.

Q.3 Why is iodine soluble in CCl_4 and not in water?

Ans. Iodine soluble in CCl_4 because it is the general rule/principle of solubility that "like dissolves like", which means that polar-substances dissolve in polar-solvents while non-polar substances dissolve in non-polar solvents. Iodine and CCl_4 are both covalent in nature so iodine dissolve in CCl_4 but not in water because water is ionic in nature.

Q.4 Why test tube becomes cold when KNO_3 is dissolved in water

Ans. When KCI are added in water, the test tube becomes cold. It means during dissolution of these salts heat is absorbed. Such dissolving process is called "endothermic". As shown in the equation:

$$\text{Solvent + Solute + Heat} \longrightarrow \text{Solution}$$

6.6 COMPARISON OF SOLUTION, SUSPENSION AND COLLOIDS

Q.1 What is difference between colloid and suspension?

Ans.

Colloids	Suspension
The particles in colloids are large consisting of many atoms, ions or molecules. While in suspensions, the particles are of largest size. These are lager than 10-5 cm in diameter. Colloidal particles are big but they can pass through a filter paper.	In suspensions solute particles cannot pass through filter paper. Main difference between colloid and suspension is tyndall effect because colloids show this effect but suspension do not show this effect.

Q.2 Can colloids be separated by filtration, if not why?

Ans. Colloids can not be separated by filtration because the particles in colloids are big but not big enough so that they can pass through a filter paper. Hence, colloids can not be separated by filtration process.

Q.3 Why are the colloids quite stable?

Ans. A colloids appears to be a homogeneous but actually it is a heterogeneous mixture. Hence, they are not true solution. Particles do not settle down for a long time, therefore, colloids are quite stable.

Q.4 Why does the colloid show tyndall effect?

Ans. The particles in colloids are smaller than suspension but larger than solution. So, they show tyndall effect in which particles of colloids scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

Q.5 What is tyndall effect and on what factors it depends?

Ans. Scattering of light in colloids is called tyndall effect. Tyndall effect is because of the particle size of colloids which is not very big nor very small particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the tyndall effect.

Q.6 Identify as colloids or suspensions from the following:

Ans. Milk, milk of magnesia, soap solution and Paint.

Suspensions	Colloids
Paints	Milk
Milk of magnesia	Soup solution

Q.7 How can you justify that milk is a colloid.

Ans. Milk is a colloid due to following reasons..

Milk particles are big but they can pass through a filter paper.

Milk particles are larger but can not seen with naked eye.

Milk particles scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

EXERCISE

MCQ'S

1. ***Mist is an example of solution:***
   (a) liquid in gas (b) *gas in liquid* (c) *solid in gas* (d) *gas in solid*
2. **Which one of the following is a 'liquid in solid' solution?**
   (a) sugar in water (b) butter (c) opal (d) fog
3. **Concentration is ratio of:**
   (a) solvent to solute (b) solute to solution (c) solvent to solution (d) both a and b
4. **Which one of the following solutions contains more water?**
   (a) 2M (b) 1M (c) 0.5 M (d) 0.25 M
5. **A 5 percent (w/w) sugar solution means that:**
   (a) 5 g of sugar is dissolved in 90 g of water
   (b) 5 g of sugar is dissolved in 100 g of water
   (c) 5 g of sugar is dissolved in 105 g of water
   (d) 5 g of sugar is dissolved in 95 g of water
6. **If the solute-solute forces are strong enough than those of solute-solvent forces. The solute:**
   (a) dissolves readily (b) does not dissolve
   (c) dissolves slowly (d) dissolves and precipitates.
7. **Which one of the following will show negligible effect of temperature on its solubility?**
   (a) KCl (c) $NaNO_3$ (b) KNO_3 (d) NaCl
8. **Which one of the following is heterogeneous mixture?**
   (a) milk (b) ink (c) milk of magnesia (d) sugar solution
9. **Tyndall effect is shown by:**
   (a) sugar solution (c) jelly (b) paints (d) chalk solution
10. **Tyndall effect is due to:**
    (a) blockage of beam of light (b) non-scattering of beam of light
    (c) scattering of beam of light (d) passing through beam of light
11. **If 10 cm^3 of alcohol is dissolved in 100 g of water, it is called:**
    (a) % w/w (b) %w/v (c) % v/w (d) %v/v
12. **When a saturated solution is diluted it turns into:**
    (a) supersaturated solution (b) saturated solution
    (c) a concentrated solution (d) unsaturated solution
13. **Molarity is the number of moles of solute dissolved in:**
    (a) 1kg of solution (b) 100 g of solvent
    (c) 1 dm^3 of solvent (d) 1 dm^3 of solution.

ANSWR KEY

1	a	3	b	5	b	7	d	9	c	11	c	13	d
2	b	4	d	6	c	8	c	10	c	12	d	KIPS	

SHORT QUESTIONS

Q.1 Why suspensions and solutions do not show tyndall effect, while colloids do?

Ans: Suspensions and solutions do not show tyndall effect because in suspensions particles are so big that light is blocked and difficult to pass. But in solution particles are so small that they cannot scatter the rays of light, thus do not show tyndall effect. But colloids can show tyndal effect because particles scatter the path of light rays thus emitting the beam of light i.e., exhibit the tyndall effect.

Q.2 What is the reason for the difference between solutions, colloids and suspensions?

Ans: Tyndall effect is the main characteristic which distinguishes colloids from solutions and suspensions because only colloids can show tyndall effect while suspensions ans solution do not show this effect.

Q.3 Why does not the suspension form a homogeneous mixture?

Ans: Suspension is a heterogeneous mixture of undissolved particles in a given medium. Particles are big enough to be seen with naked eye. These particles are so big that light is blocked and difficult to pass. That is why, solutions mixture particles should be dissolved and form a uniform mixture.

Q.4 How will you test whether given solution is a colloidal solution or not?

Ans: We will pass light in the solution, if the given solution scattered the light then it is a colloidal solution because scattering of light or tyndall effect is the main characteristic which distinguishes colloids from solution.

Q.5 Classify the following into true solution and colloidal solution Blood, starch solution, glucose solution, tooth paste, copper sulphate solution, silver nitrate solution.

Ans:

True Solutions	Colloidal Solution
Copper sulphate solution, silver nitrate solution	Blood, tooth paste, starch solution, glucose solution.

Q.6 Why we stir paints thoroughly before using?

Ans: We stir paints thoroughly before using because paint is a suspension. And suspension is a heterogeneous mix of undissolved particles in a given medium particles are big enough to be seen with naked eye particles settle down after sometime. Whenever, we use paint we stir it thoroughly because the settled down particles will suspended again in mixture and will be easy to use.

Q.7 Which of the following will scatter light and why? Sugar solution, soap solution and milk of magnesia.

Ans: Soap solution will scatter light among all because soap solution is good example of colloidal solution. colloidal solution show tyndall effect which is the main characteristic of colloidal which make them different from solutions and suspensions. So, soap is a colloidal solution.

Q.8 What do you mean, like dissolves like? Explain with examples

Ans: Like dissolves like is the general property of or general principle of solubility, which means polar solvents dissolves polar solutes while non-polar solvents dissolves non-polar solutes.

Q.9 How does nature of attractive forces of solute-solute and solvent-solvent affect the solubility?

Ans: Solution formation depends upon the relative strength of attractive forces between solute-solute, solvent and solute-solvent. Generally, solutes are solids. Ionic solids are arranged in such a regular pattern that the inter-ionic forces are the solute-solute attractive, then solute dissolves and makes a solution. if forces between solute particles are strong enough than solute-solvent forces, solute remains insoluble and solution is not formed.

Q.10 How you can explain the solute-solvent interaction to prepare a NaCI solution?

Ans: When NaCl is added in water it dissolves readily because the attractive interaction between the ions of NaCl and polar molecules of water are strong enough to overcome the attractive forces between Na^+ Cl^- ions in solid NaCl crystal. In this process, positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na+ ins. These ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong that they pull these ions from their positions in the crystal and thus NaCl dissolves.

Q.11 Justify with an example that solubility of a salt increases with the increase in temperature

Ans: Solubility of some salts which are usually ionic in nature increases with the increase in temperature for such solutes. It means that heat is required to break the attractive forces between the ions solute. This requirement falls down and test tube becomes cold.

Q.12 What do you mean by volume/volume %?

Ans: It is the volume in cm^3 of a solute dissolved in 100 g of the solution. for example: 30% of alcohol solution means 30 cm^3 of alcohol dissolved in sufficient amount of water, so that the total volume of the solution becomes 100 cm^3.

LONG QUESTIONS

(1) What is saturated solution and how it is prepared?

Ans: See the topic saturated solution.

(2) Differentiate between dilute and concentrated solutions with a common example.

Ans: See the topic dilute and concentrated solution.

(3) Explain, how dilute solutions are prepared from concentrated solutions?

Ans: See the topic preparation of dilute solution.

(4) What is molarity and give its formula to prepare molar solution?

Ans: See the topic molarity.

(5) Explain the solute-solvent interaction for the preparation of solution.

Ans: See the topic factor effecting on solubility.

(6) What is general principle of solubility?

Ans: See the topic solubility.

(7) Discuss the effect of temperature on solubility.

Ans: See the topic factor effecting on solubility.

(8) Give the five characteristics of colloid.

Ans: See the topic polarity.

(9) Give at least five characteristics of suspension

Ans: See the topic suspension.

NUMERICAL

Q.1 A solution contains 50 g of sugar dissolved in 450 g of water. What is concentration of this solution?

Given Data:

Amount of solute = 50g

Amount of solvent = 450g

Required Data

Concentration of solution = % w/w = ?

Formula

$$\%w/w = \frac{\text{mass}}{\text{solut} + \text{solvent}} \times 100$$

Solution:

$$\%\ w/w = \frac{50g}{50g + 450g} \times 100$$

$$= \frac{50g}{500g} \times 100$$

Result % w/w = 10%

Q.2 If 60 cm^3 of alcohol is dissolved in 940 cm^3 of water, what is concentration of this solution?

Given Data:

Amount of solute = v = 60 cm^3

Amount of solvent = v = 940 cm^3

Required Data

Percent v/v = % v/v = ?

Formula

$$\%v/v = \frac{\text{volume}}{\text{solut} + \text{solvent}} \times 100$$

Solution:

$$\%\ v/v = \frac{60cm^3}{60\ cm^3 + 940cm^3} \times 100$$

$$= \frac{60\ cm^3}{1000cm^3} \times 100$$

Result % v/v = 6%

Q.3 How much salt will be required to prepare following solutions (atomic mass: K=39; Na=23; S=32; 0=16 and H=I)

(a) 250 cm^3 of KOH solution of 0.5 M

(b) 600 cm^3 of $NaNO_3$ solution of 0.25 M

(c) 800 cm^3 of Na_2SO_4 solution of 1.0 M

(a)

Given Data:

Molarity = M = 0.5 M

Volume of solution = 250 cm^3

Required Data

Amount of KOH = m = ?

Formula

Amount of solute $= \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$

Solution:

Molecular mass $= 39 + 16 + 1 = 56g$

Amount of solute $= \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$

Amount of KOH $= \frac{0.5 \times 56 \times 250}{1000}$

$= 7.0g$

Result $\mathbf{= 7g}$

(b)

Given Data:

Molarity $= M = 0.25M$

Volume of solution $= V = 600\ cm^3$

Molecular mass of $NaNO_3$ $= 23 + 14 + 48$

$= 85g$

Required Data

Amount of $NaNO_3$ $= m = ?$

Formula

Amount of solute $= \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$

Solution

Amount of $NaNO_3$ $= \frac{0.25 \times 85g \times 600\ cm^3}{1000\ cm^3}$

$\frac{0.25 \times 85 \times 6}{10} g$

$= \frac{0.25 \times 510}{10} g$

Result $\mathbf{= 12.75g}$

(c)

Given Data:

Molarity $= M = 0.1\ M$

Volume of solution $= V = 800\ cm^3$

Molecular mass of Na_2SO_4 $= 23 \times 2 + 32 + 16 \times 4$

$= 46 + 32 + 64$

$= 142g$

Required Data

Amount of Na_2SO_4 $= m = ?$

Formula

Amount of solute $= \frac{\text{Molarity} \times \text{Molecular mass of solute} \times \text{Volume (cm}^3)}{1000}$

Solution

Amount of Na_2SO_4 $= \frac{0.1 \times 142g \times 800\ cm^3}{1000\ cm^3}$

$= \frac{0.1 \times 142 \times 8}{10}\ g$

Result **= 11.32g**

Q.4 When we dissolve 20 g of NaCl in 400 cm^3 of solution, what will be its molarity?

Given Data:

Amount of NaCl = m = 20g

Formula mass of NaCl = 23 + 35.5 = 58.5g

Volume of Solution = v = 400 cm^3

Required Data

Molarity = ?

Formula

Molarity (m) $= \frac{\text{Amount of solute}}{\text{Formula mass}} \times \frac{\text{volume of solute } (cm^3)}{1000\ cm^3}$

Solution:

$= \frac{20g}{58.5g} \times \frac{400\ cm^3}{1000\ cm^3}$

$= \frac{80}{585}$

Result **M = 0.136M**

Q.5 We desire to prepare 100 cm^3 0.4 M solution of Mg Cl_2, how much Mg Cl_2 is needed?

Given Data:

Molarity (M) = 0.4 M

Volume of Solution = 100cm^3

Mass of $MgCl_2$ = 24 + 71 = 95g

Required Data

Amount of $MgCl_2$ = m=?

Formula

Amount of solute $= \frac{\text{Molarity} \times \text{Formula mass} \times \text{volume } (cm^3)}{1000\ cm^3}$

Solution:

$= \frac{0.4\ M \times 95\ g \times 100\ cm^3}{1000\ cm^3}$

$= \frac{38.08}{10}$

Result **= 3.8 g**

12 M H_2SO_4 solution is available in the laboratory. We need only 500cm^3 of 0.1 M solution, how it will be prepared?

Given Data:

Molarity of concentrated solution $= M_1 = 12\ M$

Molarity of dilute solution $= M_2 = 0.1\ M$

Volume of dilute solution $= V_2 = 500cm^3$

Required Data

Volume of concentrated solution $= V_1 = ?$

Formula

$$M_1 V_1 = M_2 V_2$$

Solution:

$$V_1 = \frac{M_2 V_2}{M_1}$$

$$V_1 = \frac{0.1M \times 500\ cm^3}{12M}$$

$$V_1 = \frac{1}{10 \times 12} \times 500\ cm^3$$

$$V_1 = \frac{500}{120}\ cm^3$$

Result **4.16 cm^3**